REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 20, 2002	Final Technical Report

4. TITLE AND SUBTITLE

Nanoimprint Lithography of Parallel Patterning of Nanoscale Magnetoelectronic Devices

5. FUNDING NUMBERS

N00014-02-M-0115

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11. SUPPLEMENTARY NOTES

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12a. DISTRIBUTION AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Final technical report.

14. SUBJECT TERMS

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

[redacted]

Final Report to Office of Naval Research

Project: "Nanoimprint Lithography of Parallel Patterning of Nanoscale Magnetoelectronic Devices"

Supported by ONR (Contract #: N00014-02-M-0115, Manager Dr. Kristl Hathaway)

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(N02-055)

December, 2002

Work Progress:

In the last 6 months, Nanonex Corp has developed technologies based on nanoimprint lithography for parallel patterning of nanoscale magnetoelectronic devices. The details are discussed in the following.

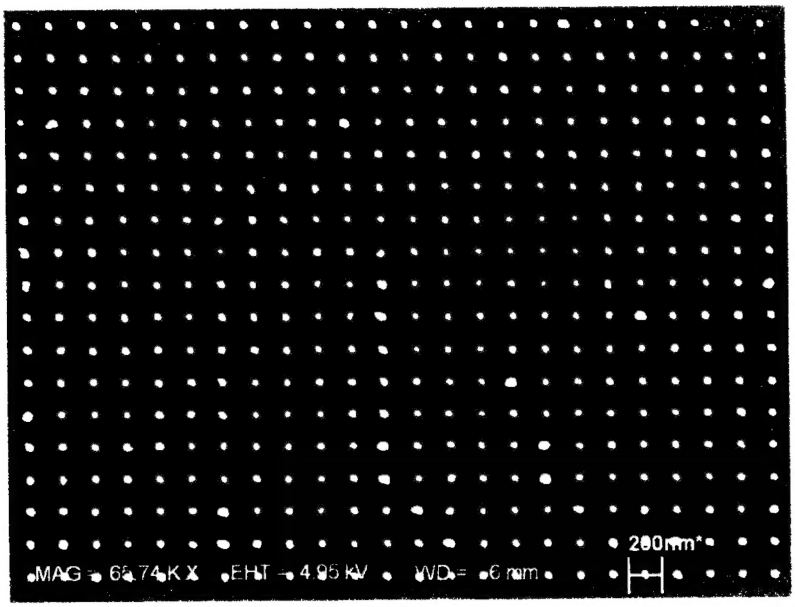
(a) Nanonex Corp. has fabricated NIL masks with pillars that have diameters from 20 nm to 50 nm and height as large as 80 nm. Different mask materials, such as SiO_2 wafer and glass wafer, were used. Figure 1 shows the SEM and AFM images of masks with pillars patterns.

(b) Nanonex Corp. has tested new NIL resists for sub-50 nm patterning. One example is double-layer resist, which is very good for small pattern imprint. As we know that the small patterns on the mask cannot be very high otherwise they could be broken during imprint process. The top resist in our double-layer resist has a much lower etch rate than the bottom. This can allow us to imprint the patterns into a very thin top resist, then transfer the patterns into the bottom layer which can be thicker and make the lift-off easier.

(c) Nanonex Corp. has patterned Co/Cu/Co magnetic multilayer. The patterns are dots with diameter around 50 nm, as shown in Fig. 2. Scanning electrical microscope and atomic force microscope were used to characterize the samples.

(d) Nanonex Corp. has built NIL tools that have many advantages, such as excellent uniformity over 4-inch wafer, and machine cycle times of less than 1 minute. Figure 3 shows a photograph of an NIL machine built by Nanonex Corp.

(e) Nanonex Corp. has studied the electro-deposition in nano holes. Several electrolytes have been tested. For the electrolyte which includes $CoSO_4$, $CuSO_4$ and H_3BO_3, first, the deposition rate of Co and Cu was calibrated. Then multilayer of Co/Cu was deposited. Co was deposited at potential of – 1.4 V and period from 0.01 seconds to 0.04 seconds, and Cu was deposited at potential of – 0.3 V and period of around 5 seconds. SEM and AFM images show that the deposition multilayer looks good. It was found that the deposition rate depends on the pattern size and area.



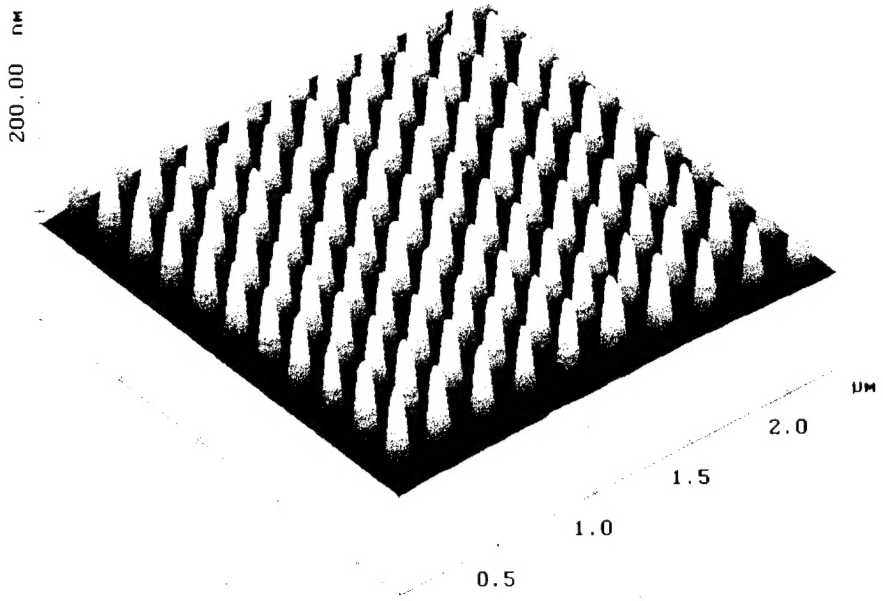


Fig. 1 SEM and AFM images of NIL mask with sub-50 nm pillars. SEM shows the pillar size is around 40 nm and AFM shows the pillar height is around 70 nm.

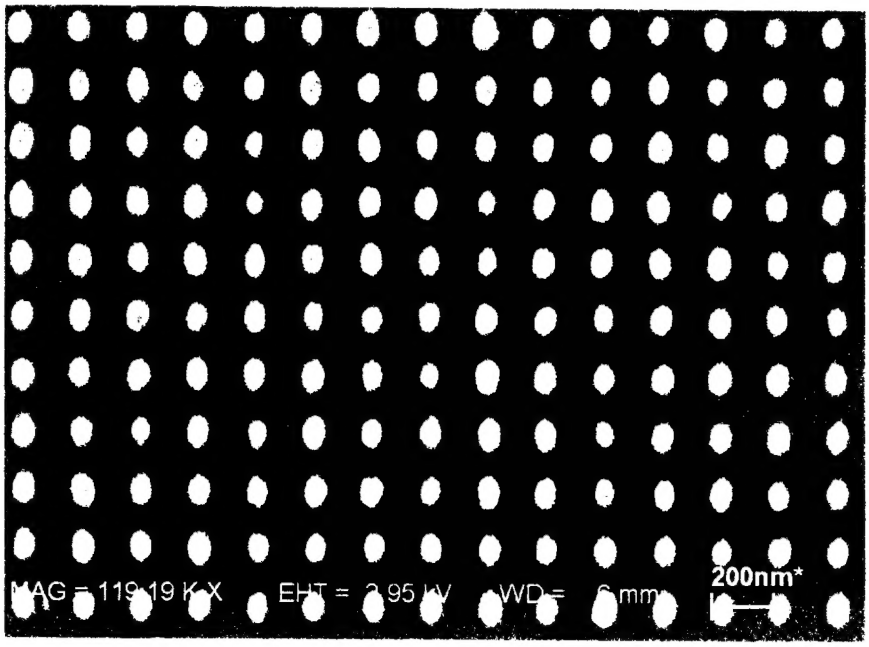


Fig. 2 SEM image of Co/Cu/Co magnetic multilayer patterned by double-layer resist.

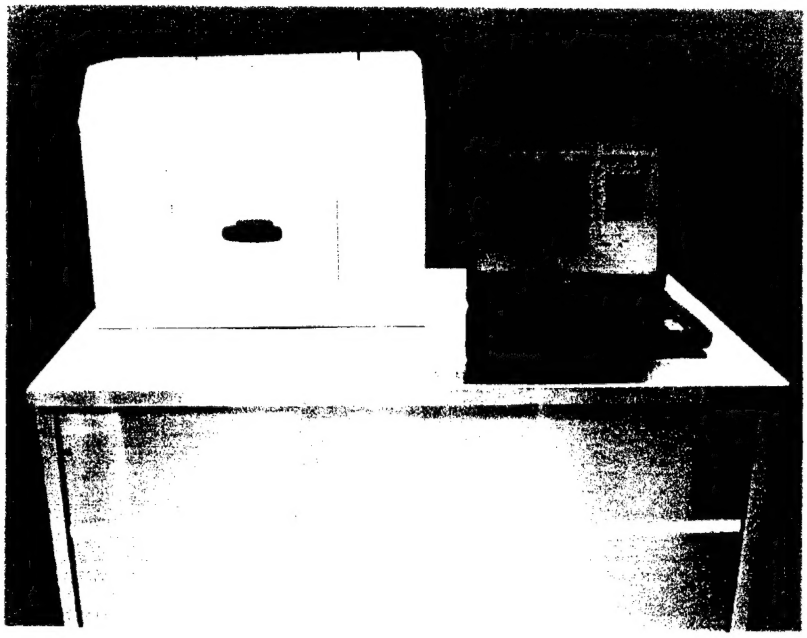


Fig. 3 The NIL machine built by Nanonex Corp.